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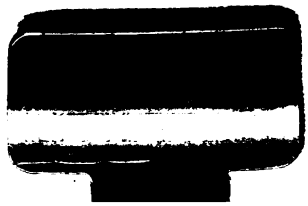

THE HILL KINK BOOKS

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Screw Machine Kinks

COMPILED BY

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INTRODUCTORY WORD

THE kinks and other information given in this book have been selected from the experience of thoroughly practical men, as originally published in the *American Machinist*. This volume forms one of a series of this nature, aiming always to make available out-of-the-way information when most wanted. In this form the Kink Books, which can be kept in the tool-chest or the pocket, and always referred to, will, we feel, meet a demand and serve a good purpose.

F. H. COLVIN.
F. A. STANLEY.

NEW YORK, November, 1907.

SCREW MACHINE KINKS

TOOLS FOR MAKING NUTS

We once saw an automatic equipped for making ½-inch nuts from the hexagon bar, drilling, tapping, chamfering both inside and outside, and finishing complete in the one operation, and think the tools may be of interest to some engaged in screw-machine work.

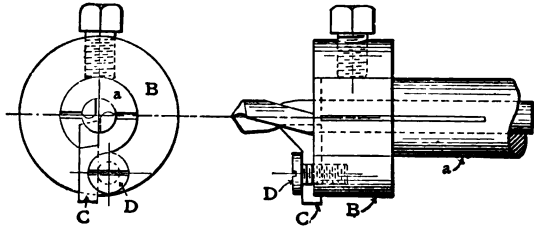


Fig. 1. — Tool for Drilling and Chamfering a Nut in the Automatic.

The turret had four holes, and Fig. 1 represents the first tool; a regular drill-holder carrying the drill, and the tool *C* held by the screw *D*,

the tool fitting nicely in a slot in the face of the clamp collar *B*. The inner end of the tool *C* is set into the groove of the drill and chamfers the front end of the hole. The outside of the nut is chamfered both back and front like a regular

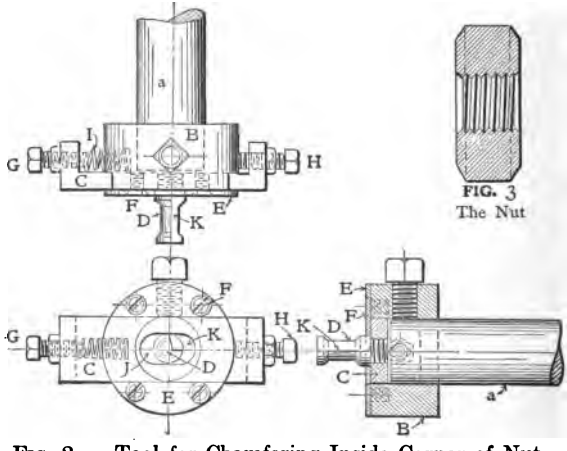


FIG. 3
The Nut

Fig. 2. — Tool for Chamfering Inside Corner of Nut.

check-nut, and a circular tool on the front of the cross-slide is forming the outside of the nut, facing the front and necking down in back for the cutting-off tool, simultaneously with the drilling operation. Fig. 2 shows the tool for

chamfering the back end of the hole, and consists of a blank drill-holder *A*, fitting the turret, and the collar *B* having a slot planed across its face to admit the slide *C*. The thin plate *E* is fastened to the collar by the four screws *F* to keep the slide in place.

The slide is shown in its central position and carries a small circular tool *D* for recessing or chamfering the back end of the hole. The plate *E* is cut out at *J* to clear the tool. The tool is of a size to just enter the hole without cutting, and is kept in a central position, except when performing its cutting operation, by means of the check *H* and the spiral spring *I*.

The cutting-off tool-post on the back side of the cross-slide carries a small plate at the right hight to engage with the screw *G*. The turret-slide brings the tool quickly into position and stops while the cross-slide feeds forward, operating the slide *C* and forcing the cutting edge *K* of the tool into its cut. The cross-slide moving backward allows the spiral spring to bring the tool into its central position again when it is withdrawn from the whole by the turret slide.

Two taps were used on the job, and were held in ordinary revolving die-holders. The first was about $\frac{1}{32}$ inch under size, and at the front end was tapered in the bottom of the thread as well as at the top. The second, or finishing tap, had very little chamfer, it having to cut a full thread to the bottom of the hole. The forming tool necking down on the outside, and the recessing or chamfering tool removing considerable stock from the inside, very little was left for the cutting-off tool to do to complete the job. The hole was drilled just deep enough to leave a small center in end of bar after the nut was cut off.

Considerable trouble was experienced at first with chips getting between the end of taps and bottom of the hole. The difficulty was overcome by connecting a small piece of pipe with the regular oil pipe and bending the end so that it would direct the oil into the hole and force all chips out.

Fig. 3 is a section through the center of the finished nut, showing inside and outside chamfer.

A RECESSING TOOL–HOLDER FOR THE AUTOMATIC

Fig. 4 may interest our friends who have any inside recessing to do. The object in this design was to secure a powerful oil supply for the cut-

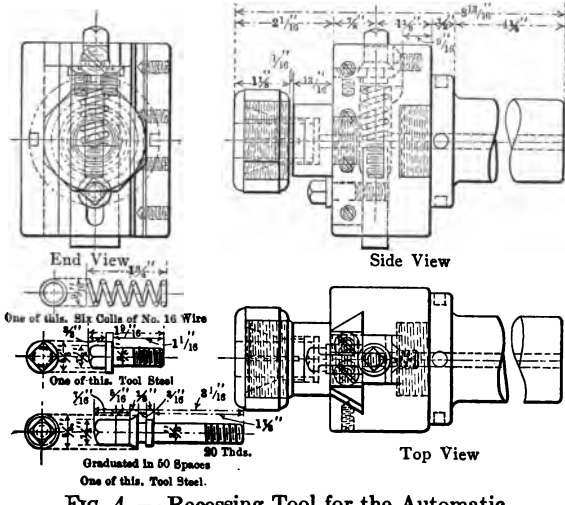


Fig. 4. — Recessing Tool for the Automatic.

ting edge of the tool — something to wash out the chips. We had been using the ordinary style which swings on a stud, but had trouble. The

hole would fill up with chips, preventing the tool from releasing, then when the turret returned the tool would break. Besides, we could never make two jobs alike, and the holder was gradually making us desperate. Well, one day when the inspector had just got through explaining the inferiority of automatic machines as compared with hand machines, and for proof had exhibited a few recessed pieces, we submitted to him this sketch. We believe a lengthy description is unnecessary. The side view shows the adjustment. At the bottom is a plate tapped out at the top, into which is fitted a screw with graduated collar. In adjusting you loosen the screw whose head is shown at the front of the plate, turn the graduated screw, then tighten. The coiled spring around the adjusting screw holds the tool central except when in operation. The shank is screwed into the slide block, which makes the tool-holder interchangeable for the several sizes of holes in automatic machines. We will say that we have found this tool-holder very satisfactory.

TURNING BALLS IN THE SCREW MACHINE

A LARGE quantity of balls was wanted for a certain purpose, and it was found that those made on the automatic screw machine by the usual method — that is, with a forming tool made in a half-circle — were not accurate enough to answer the purpose, so a special tool, Fig. 5, was designed that would turn a perfect sphere.

Referring to the sketch, *a* is the ordinary form of square box tool which is bored out to receive the turntable *b*. The turntable has a tool-post with the usual set-screw, and is slotted to receive the tool *c*. On the under side of the pivot of the turntable is secured a spur gear, and engaging with it is the rack *d*. The rack is held in place by the plate *e*, which also serves to cover the gear and prevent its filling with chips. When the rack is moved sideways it is obvious that it will cause the turntable to rotate, carrying the tool in a true circle, and it will of course turn any size of ball which the tool-post will clear.

The first operation is performed by a circular forming tool shown at *f*, which cuts off the finished

ball, and, continuing on, roughs out the next one on the end of the rod. The rod is now fed for-

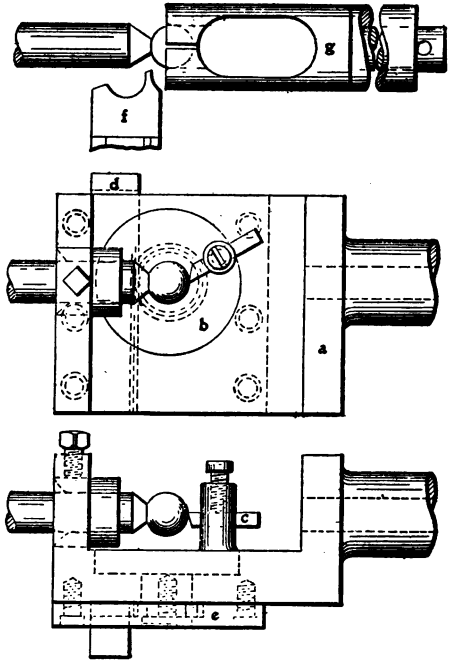


FIG. 5. — Ball-turning Tools.

ward to a stop in the turret and the turning tool is swung around in place. The cam for this

operation is set straight on the drum and merely brings the tool up to place and holds it stationary. As the tool is brought forward, a projection on the end of the rack *d* enters a slot in the dog clamped on the cross-slide to receive it. The cross-slide is now moved slowly by its cam, drawing the rack and rotating the turntable and tool. The rack should be placed at the front end of the box as shown, so that the cut will be made by drawing the rack toward the back side of the machine. This will draw the tool slightly to one side, there being of course a little clearance between the stock and bushing; this clearance, however, should be very slight. When the cut is finished, the rack pushing the other way to return the tool into place will crowd the box to the front side; as this gives the tool a slight clearance on its return it does not leave a mark on the work.

If a particularly fine job is wanted, two of these tools should be used, the second taking a very light cut which will, of course, be uniform all the way around. To cut the ball off, a revolving spring holder *g* is used which grasps and

supports the ball and allows it to be cut off without any burr. It is not necessary to provide an ejector for this holder, for the ball will be pushed back by the following one and drop out of the opening shown in the side.

By using two tools, balls may be turned of machine steel very accurately, and if properly case-hardened and polished just enough to remove the tool marks, they make a very good ball; for, having a soft center, they will never split and a good case-hardening will penetrate deeper than the balls will ever be called upon to wear.

MAKING LOCK NUTS

WHEN a quantity of small parts are to be made, the output can be increased and the cost kept low by making two or more parts in one operation. The pieces made with the tools shown in Fig. 6 are turned out three at a time on the screw machine; they are for sprocket locknuts and are tapped in another machine. About 150,000 are required each year. The dimensions are as follows: Diameter of stock, $1\frac{3}{4}$ inches;

diameter of formed ring, $1\frac{21}{32}$ inches; length, $\frac{3}{16}$ inch; diameter of hole, $1\frac{9}{64}$ inches. We have no trouble in making 700 of these lock-nuts in ten hours, on one machine.

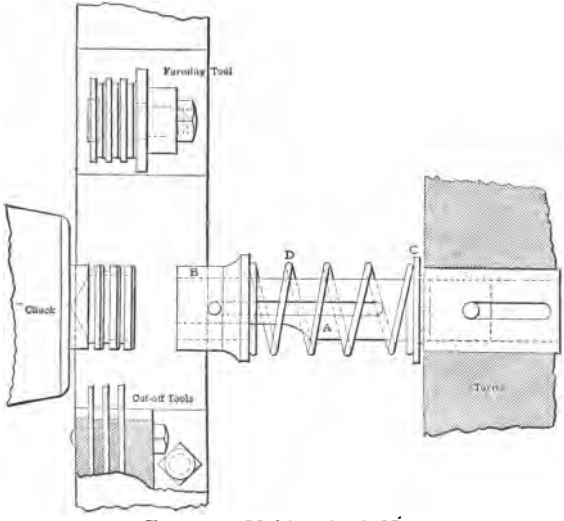


FIG. 6. — Making Lock Nuts.

The tools are of good carbon steel — we say carbon, as we use air-hardening steel on several jobs. The turret tools used are: stop, $1\frac{1}{4}$-inch drill, $1\frac{9}{64}$ inch reamer — "four lip" — and spring

tool for removing the parts from the cut-off tools. The cams are arranged so that the forming tool and drill work together, and the reamer and cut-off tools work together; the pieces are nearly cut off while the reamer is going in, and the cut-off tools and spring tool then work together. The cut-off tools are brought into operation the second time by what we call double camming.

As the pieces are nearly cut off, the turret comes well forward and plunger *A* enters the hole. Sliding collar *B* comes against the first piece before the feed is thrown in and cut-off tools commence to cut. A portion of plunger *A* is cut away at the outer end so that the tools will not strike it.

The split taper collar *C*, which one end of spring *D* presses against, acts as a retarder so that when the turret advances towards sliding collar *B*, plunger *A* will feed into the hole as rapidly as the turret is brought forward until it strikes the bottom of the hole in the formed pieces; then the plunger slides in the sleeve in the turret.

The cut-off tools complete their work when the turret lacks about one inch of completing its forward travel; then the feed is thrown out, and turret is brought forward rapidly and at the same time the cut-off tools are withdrawn. This leaves the three pieces on plunger *A* from which they are thrown or stripped by the spring and collar *B* as the turret returns.

Four, or perhaps five, pieces like these could be made in the same manner, but the best results are obtained by not drilling a hole any deeper than can well be flooded with oil; of course an oil tube drill could be used providing the machine were fitted for it.

The object of the spring tool is to insure that no pieces will be left between the cut-off tools. Plunger *A* should be about $\frac{1}{16}$ inch loose in the hole, so that any burr thrown up by the cut-off tools will not make the rings stick on the plunger and prevent the sliding collar *B* from operating. It is a good plan to groove the face of the collar that comes against the work, for we have found that if the surface is left unbroken, ofttimes the nuts stick to it; as oil, after it has been used for

some time, becomes quite thick and has considerable adhesive power. It is advisable not to drill and ream any deeper than necessary, as the last piece, or piece next to the chuck, is apt to stick to the end of the bar if the small burr or ring left from the cut-off tool is forced into the hole, and when the drill comes forward and enters the hole the forming tool is apt to break, as the spring will not rotate so the tools can cut.

TOOLS FOR MAKING WASHERS ON THE AUTOMATIC

THESE tools, Fig. 7, are for $\frac{7}{8}$-inch washers, $\frac{1}{8}$ inch thick, with $\frac{1}{3}\frac{3}{2}$-inch holes and chamfered on one side. The largest of the set of cutting-off tools is 3-inch diameter; the second, $2\frac{7}{8}$ inch; the third, $2\frac{3}{4}$-inch; the fourth, $2\frac{5}{8}$-inch. Each is $\frac{3}{3}\frac{3}{2}$-inch thick, has a $1\frac{1}{4}$-inch hole, with keyway, and is hardened and ground. The spacing washers are the same thickness as the washer to be made, and all are assembled on a sleeve as shown, the distance from the face of the collar to the end being $\frac{1}{6}\frac{1}{4}$ inch less than the total

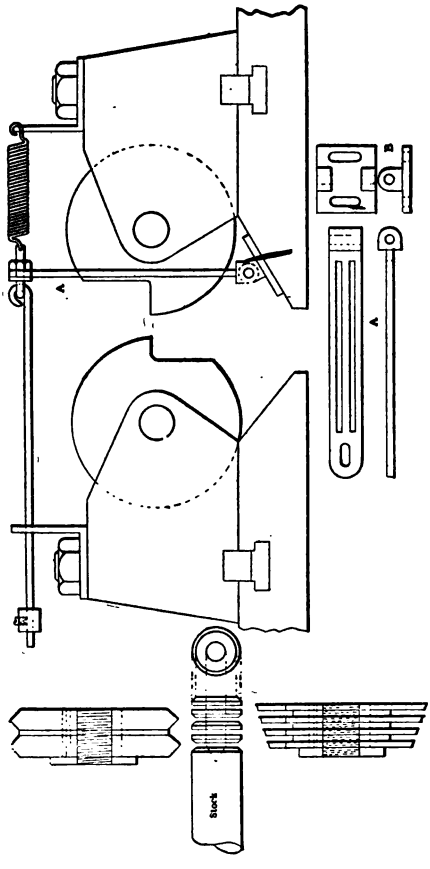


FIG. 7. — Tools for Making Washers.

length of tools and spacers to enable the tools to be drawn up to the side of the tool-post. The chamfering tools are made and held in similar manner. They are made for a Brown & Sharpe No. 2 automatic forming machine, the cross-slides being made in two parts and operated by separate cams, enabling front and back tools to be operated at the same time. The chamfering tools get through with their operation first and return to their former position. The first washer cut-off, being on the outside, drops off and the remaining three are held between the tools until released by the knock-out lever *A*, which is shown in position. The collar on the rod is set to bring the lever to the edge of the cut-off tools, or a little inside to keep it from getting caught on the front of the tools. The spring will pull the lever back against the spacing washers when the tools proceed to the next cut. The small angle iron *B* is $\frac{1}{8}$-inch sheet steel, $\frac{7}{8}$-inch wide, and held, as shown, under the head of the tool-post bolt.

The machine has two sets of tools in the turret, and the cams are cut double; so we get eight

washers for each revolution of the turret. The time required to make each washer is 6¼ seconds.

ADJUSTABLE NURLING TOOL

FIG. 8 shows an adjustable nurling tool, made

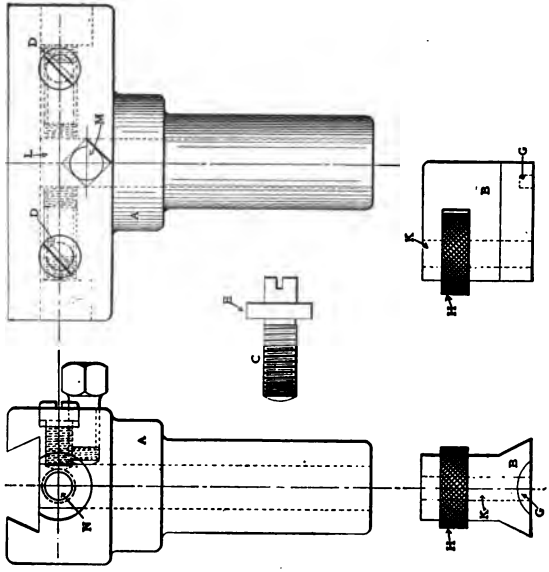


FIG. 8. — Adjustable Nurling Tool.

eight or ten years ago, which has performed very satisfactory service. The rectangular head of

the holder has a dovetailed slot planed through, in which the two blocks *B* are made a neat sliding fit. These blocks carry the nurls *H*, adjustment to and from the center being obtained by means of the two screws *C* fitting tapped holes *N* in the head. The collar *E* on screw *C* fits into notch *G*, in block *B*. Set-screws *D* lock the adjusting screws when set.

The pins *K* are of tool steel, hardened. Set-screw *M* may be used to fasten a bushing to support the end of the piece being nurled, which bushing may be replaced when worn, or it may hold a drill.

By using a drill in hole *L* it is possible to drill a hole in the center of the piece being operated upon, at the same time that the nurling is done on the outside; which, by the way, is quite a frequently occurring job. This, of course, saves, usually, the time required for a separate operation. In use, most of the pressure is back against the shank, and there is very little strain on the screws *C*.

A TAPPING KINK

WE were using a large number of $\frac{1}{4}$-inch rods, Fig. 9, in one end of which there was required to be an $\frac{8}{32}$-inch hole, tapped as deep as the length of the thread on the tap, which resulted in so many broken taps that we finally hit upon the idea of drilling into the rod a slightly larger hole

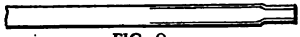


FIG. 9

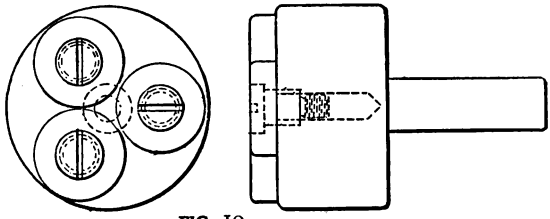


FIG. 10

Tool for Rolling Down End of Stock.

than the body size of the screw to the depth required, and then rolling the end of the rod for about $\frac{1}{4}$ inch in length until the hole was the tapping size, which made the work of the tap much easier, and the reduction of the outside diameter of the rod did not interfere with its usefulness.

Fig. 10 shows the tool made to be used in a screw machine. As it is fed onto the end of the work, the outer corners of the rolls are first rounded and then slightly tapered up to the full size of roll. The round and taper portions are nurled with a fine, straight-tooth nurl, and in practice the tool is started onto the work with sufficient force to make an impression of the small teeth on the work which keep the rolls revolving.

We first tried it without the nurling, but the friction of the small rod was not enough, any one of the rolls being liable to stop at any time.

A TURRET-LATHE TOOL FOR CONES

THE drawing, Fig. 11, illustrates a turret-lathe forming tool designed for making ball-bearing cones. The object in devising this tool was to obtain a very rigid affair that would turn out work accurately and in large quantities. Another object was to be able to grind the cutting tool readily without changing the size of the finished work.

The stock operated upon was round tool steel in the bar and the duty on the cutting tool was quite severe. In making the cones a hole was first drilled into the bar, after which the forming tool, having a supporting pilot to enter the drilled hole, turned off the outside and formed

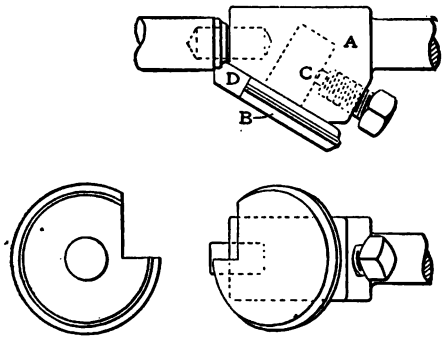


FIG. 11. — Tool for Making Cones.

the ball seat; then a tool on the cross-slide cut the cone off to the right thickness ready for tapping. In the drawing *A* is the body of the tool, which has a shank adapted to fit one of the holes in the turret. One side of the body is beveled to an angle of 30 degrees, with the axis of the shank, and at right angles to this side is

formed the hole to receive the shank of the circular tool *B*, which can be readily taken out and sharpened without changing the size and shape of cut. The shank of the cutter is securely held by means of a clamping screw, with a concave disk *C* interposed between the end of the screw and the shank. The pilot inserted in the forward end of the body is of tool steel, hardened and ground.

More rake could have been given to the cutter had it been desired, by inclining the upper part of the side *D* toward the center of rotation and consequently inclining the hole for the cutter shank; but this was not found to be necessary in this particular tool, which gave satisfaction as long as these cones were made.

STOP FOR CUTTING OFF STOCK IN THE TURRET LATHE

A CHEAP stop for use on a screw machine when cutting off stock is shown in Fig. 12. It is customary when cutting off stock, say from $\frac{1}{16}$ to $\frac{1}{2}$ inch diameter, if the pieces are long, to turn

the turret slide around end for end, as shown. In that way a much longer piece can be cut and the stop can be used. When the slide is in its normal position the turret can be moved away after locating each length to be cut, but not so when it is reversed. The result is that when the chuck is tightened on the stock, it is pushed forward,

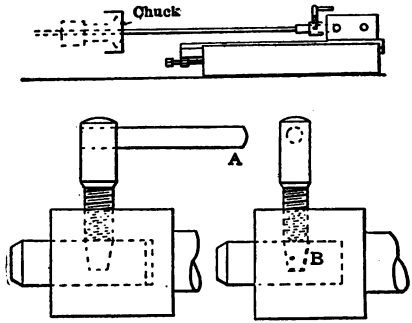


FIG. 12. — Stop for Cutting off Stock.

say, from two to ten thousandths of an inch (when being tightened), which makes it jam against the stop, and causes trouble when it is cut off. *A* shows the stop of which we speak when ready for use, and *B* shows it after the work has been located and is being cut off. You

just give the lever a quarter of a turn, or less, and the stop moves back and away from the end of the piece being cut, as shown at *B*. When the next piece is to be located, you just pull lever *A* back to its original position, and the stop comes back to exactly the same place.

A FRICTION DIE-HOLDER

HAVING recently had trouble with the breaking of the throats of small dies when working close against the shoulders on small screws, the means by which we overcame the difficulty may be interesting to those of the craft having similar experiences. The work on hand was the making of a great quantity of small screws of very fine pitch requiring only 2½ and 3 threads and those close against the shoulders of the screws. After trying many different die-holders we finally designed one, a sketch of which is given in Fig. 13.

This die-holder operates on much the same principle as those in ordinary use, with the exception that the steel friction disk *A* between the fiber disks *B B* takes the place of the slip

pins in an ordinary die-holder. By adjusting plug *C* the required tension is given to be just sufficient to keep the die from turning until it strikes the shoulder.

When reversed, the keyway *D*, better shown in the end view, engages with the spring-backed stop-pin *E* and releases the die from the screw.

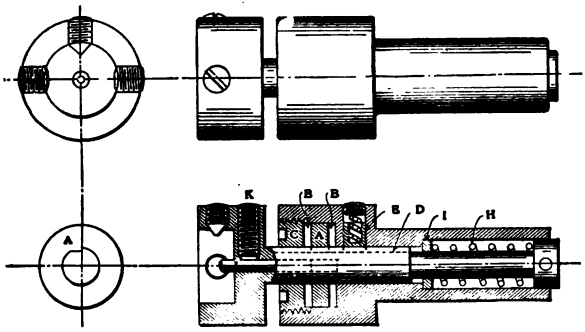


FIG. 13. — A Friction Die-holder.

The end view shows the friction disk *A* and the form of the keyway in the spindle. Spring *H* and collar *I* are to retain the holder to its original position when the die is released from the screw.

Pin *J* and set-screw *K* are used only when working on the end of a screw. When pin *J*

comes in contact with the end of the screw, the holder will slip the same as when working against a shoulder. This die-holder has been in successful operation on both automatic and hand machines, and so far we have had no trouble from the breaking of dies.

AN IMPROVED DIE-HOLDER

FIG. 14 is a drawing of a die-holder which is a departure from the usual style and has some good features. Instead of the usual spiral cut on the rear end of the shell to catch a pin in the spindle when the die is run off the work, the shell is splined as shown in the drawing and a latch inserted in the spindle, with a spiral spring under it to hold it up to its work.

Threads are often stripped on automatic machines by the extreme point of the spiral in the usual form of holder becoming worn until the pin catches there and does not allow the lateral play of the spindle which conpensates for the difference between pitch of cam and lead of screw.

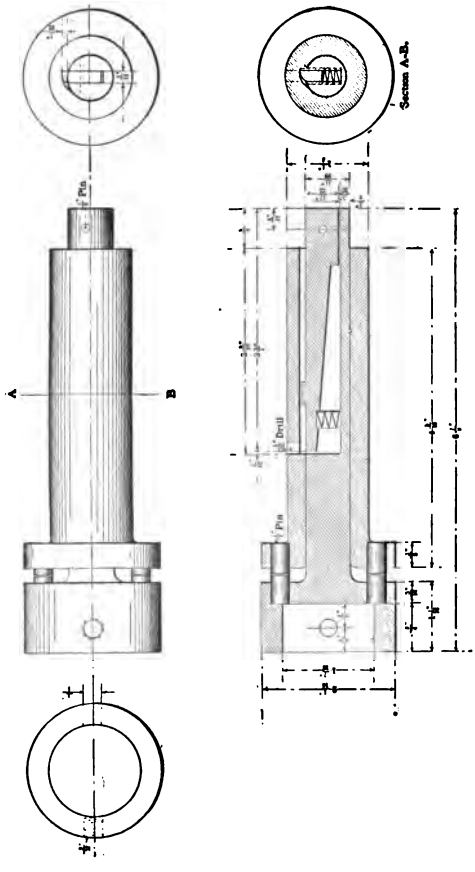


FIG. 14. — An Improved Die-holder.

The latch-holder overcomes this trouble and allows greater endwise movement to the die, thus requiring less adjusting of the die cam for different lengths and pitches of screws.

The die and spindle can be removed from the machine without moving the shell, and returned to proper place without adjusting, which is a very good feature in setting up a job.

ANOTHER DIE-HOLDER

FIG. 15 shows a die-holder that gives the best of satisfaction and can be used on long or short, fine or coarse threads.

An improvement is in the backing-off device *D*. When the spindle is reversed, *D*, being held forward by the spring, interlocks at once with sleeve *B*, thus avoiding the pull which in some die-holders often strips the thread.

All parts, with the exception of the pins, are made of soft steel and case-hardened. As the holder *A* and the spindle *C* are made separately they can be finished all over after hardening, and either part can be replaced. *A* is lapped to the

standard size of dies, and C is ground all over, a flat being ground on the head so that it can be drilled from A when the two parts are put together. The sleeve B is ground outside and

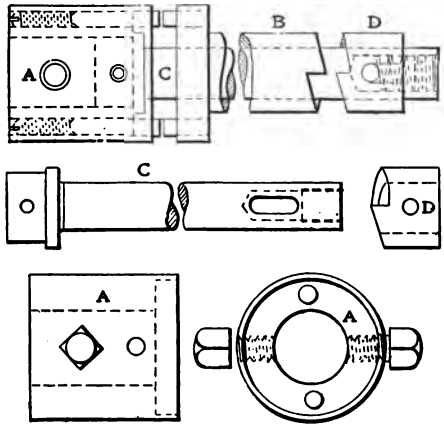


FIG. 15. — Another Die-holder.

lapped inside and should be an easy fit on C. The driving pins in B project the depth of the counterbore in A. The pins in A are adjusted to suit the job in hand.

TAP AND DIE-HOLDER

In Fig. 16 is shown a reversing tap or die-holder of rather a useful type. The holder proper, *A*, has segment pieces *B* attached to it by a screw and dowel pin each; these segment pieces are made 60-degree included angle. The

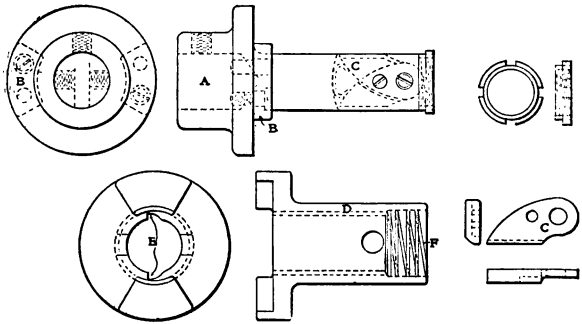


Fig. 16. — Tap and Die-holder.

shank is slotted for two small tongues *C*, which are held together by a small stud. These tongues are held as required from moving by two small screws, one of which must always be tightened so as to allow the other to be moved by the spring. Piece *D* is the main body and has seg-

ments corresponding to those on *A*, only machined out of the solid; it has also two parallel keyways *E*, and is recessed at the back to take the spring *F*. A hole is drilled also through the shank, so that either one of the tongues can be placed into action; the holder is thus adjustable for either right- or left-hand threading. The action of the holder is easily seen. When it is released from the segments it revolves until the reverse speed is thrown on and then the tongue is thrown into the slot and backs the tap or die out. The spring on the end should be just strong enough to bring the holder back again, so that it may be used on an automatic machine and save time. This type of holder has been used with much success and seldom requires repairing.

A FLOATING REAMER HOLDER

THIS floating reamer holder, Fig. 17, is made for use in the automatic screw machine. As will be seen from the drawing, *A* is the body provided with a shank to fit the turret holes; it

is bored out to receive the floating part B and its spring, and drilled for two hardened pins C,

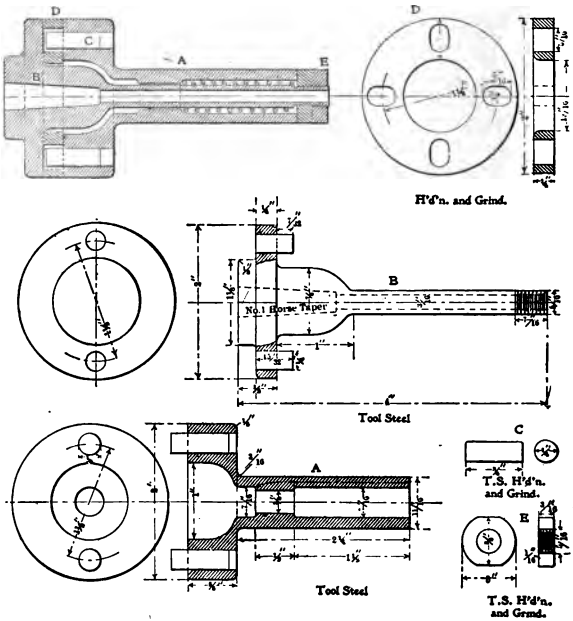


FIG. 17. — Floating Reamer Holder.

which are $\frac{1}{4}$ inch diameter and $\frac{3}{4}$ inch long. B is also drilled for two $\frac{1}{4}$-inch pins; it is provided with a taper hole for reamer shanks and a $\frac{3}{16}$-

inch hole is drilled from the bottom of the taper clear through the shank. *D* is a hardened and ground collar in which are four $\frac{1}{4}$-inch slots, $\frac{5}{16}$ inch long, and this collar, when placed as shown between the heads of *A* and *B* connects these two members, and yet allows *B* to travel $\frac{1}{32}$ inch from the center in any direction. The spring and the lock-nuts *E* keep *B* perfectly square with the turret, yet allow it to slide freely. This holder is neat looking and easily made, and can be left without danger in automatic machines.

TURRET TOOL FOR SMALL WORK

THE tool shown in Fig. 18, while being similar to many turret tools, embodies one feature that may prove of interest. It was designed for use in turning small brass studs, screws, etc., upon which the limit of variation was small and in which were embodied several sizes and shoulders. Samples of the work are shown in the sketch.

Where the piece is short and it is desirable to do so, the tool can be fed into the stock by the feed screw of the box tool, and where the piece

is so long that this it not practicable it is fed on from the end and the relative diameters are

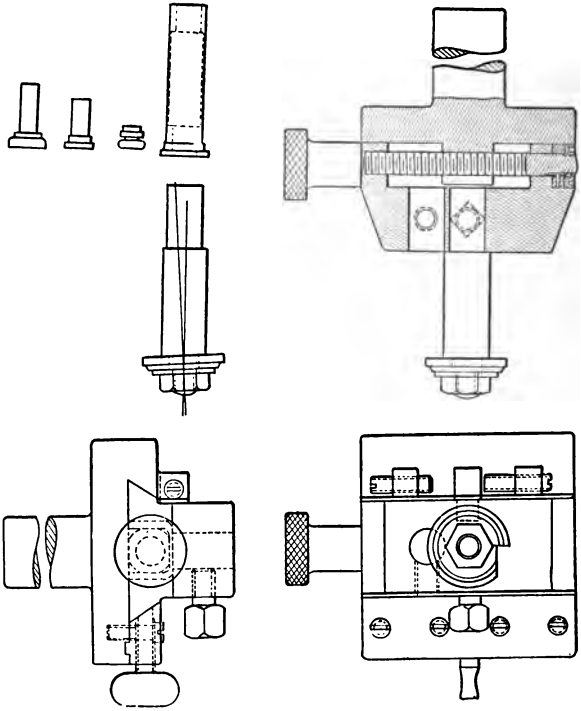


FIG. 18. — Turret Tool for Small Work.

fixed by the diameters of the circular tool. To give a cutting clearance to the tool it was held

on a stem, the end of which was turned at an angle to the center line of the stem. It is possible to make the corners and fillets on tools of the circular type more symmetrical than on small square tools and the life of the tool is much longer. This also makes a good boring-tool holder and can be used for recessing or boring several sizes in a piece without rotating the turret.

A feature often overlooked by users of turret lathes having a horizontal-lock bolt is that the work will be more uniform in size when the tool operates above the work than it will when on the side.

INSIDE GRIPPING SPRING CHUCK

FIGS. 19 and 20 show a form of spring chuck which may be new to many, even though they are familiar with the ordinary push-out and draw-in chucks for holding rods and wires.

The present adaptation of the spring chuck principle is intended for work that has been machined on the inside and requires to have turning done on the outside.

Fig. 19 is a side elevation and Fig. 20 a longitudinal section of the chuck. The cast-iron sleeve *A* is bored and threaded at *B* to fit the nose of the lathe or screw-machine spindle, and

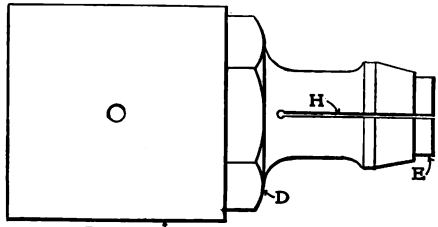


FIG. 19

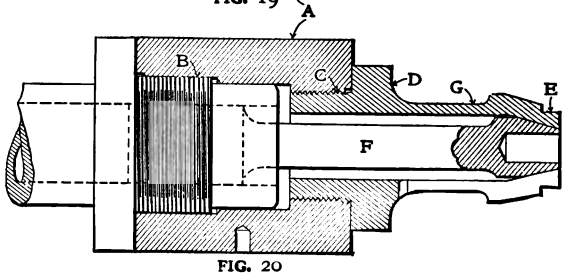


FIG. 20

Inside Gripping Spring Chuck.

the part *C* is threaded internally to fit the spring chuck *D*. Thus the chuck may be used on other lathes with larger or smaller spindles by making another sleeve similar to *A* to fit the particular

machine. The chuck *D* has a hexagonal part by which to screw it into the sleeve, while the latter is screwed to place by a spanner wrench.

The extreme front end of the spring chuck has a seat *E* to fit the finished interior of the work, and the latter upon being placed in position on this seat is firmly held by moving the plunger *F* toward the right. The chuck has at *G* a thinner portion which is sawed through in three places, as at *H*, and this gives the required spring to the chuck, which is tempered in the usual way.

This style of spring chuck will take quite a heavy cut and yet run very true, and not allow the work to slip on the seat.

A CHUCK FOR TWO OPERATIONS

THE sketch Fig. 21 shows a chuck designed to perform two separate operations. As indicated the device consists of a cap and split chuck for the screw machine. The work *A* is first roughed out in a large machine, after which it is screwed into the cap *B* and the shank finished to size; th

small hole may also be drilled at this setting. Before screwing the work in place, the operating lever of the machine is thrown over, thus causing the spring chuck *C* to project a trifle in front of the cap and also holding it rigid so that the work

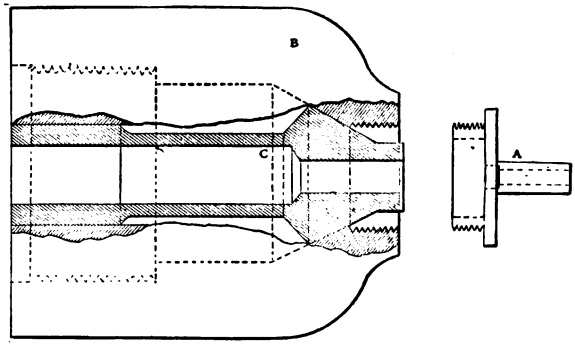


FIG. 21. — Spring Chuck for two Operations.

may screw up tight against the end. By releasing the chuck the end pressure is removed and the work easily screwed out. It is then reversed and the shank gripped by the chuck while the other end is finished to size.

A NEW DESIGN FOR SPRING CHUCKS

SPRING-CHUCK designs of various degrees of utility have been described from time to time, but it is believed that the form illustrated in Figs. 22 and 23 has received little attention up to the present. This form is intended for

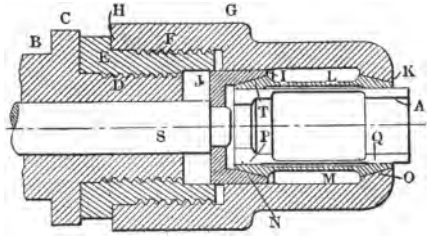


FIG. 22. — Section through Collet and Closer.

use on screw machines and turret lathes where very accurate work is desired, or where the work is in long pieces, and especially where it requires to be finished inside.

The form illustrated is intended for boring, reaming and recessing tubular pieces of machinery steel as indicated in Fig. 22, where the tubular piece of work is lettered *A*. This view is a longi-

tudinal section of the forward end of a lathe spindle, the spring chuck and the members required to operate it or secure it to the spindle. Fig. 23 shows the chuck in detail, presenting front and side elevations.

Referring to Fig. 22, the nose of the lathe spindle is indicated by *B*, and it has the usual collar *C* and threaded part *D*, upon which is

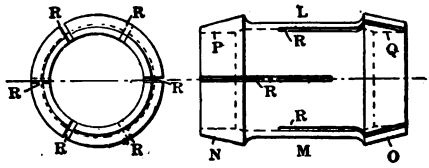


FIG. 23. — Collet Detail.

screwed the internally threaded sleeve *E*, which is also threaded externally at *F*. On the thread *F* is screwed the outside sleeve *G* hard against the shoulder *H* of the sleeve *E*. The sleeve *G* has a cylindrical bore at *I* to fit the sliding cup-shaped closer *J*, and has an internally tapered portion *K* at the extreme forward end.

The spring chuck proper *L* consists of a barrel *M*, and tapered portions *N* and *O*, while the

inside of the chuck is bored to fit the work, care being taken to recess the central part of the bore, leaving bearing spaces *P* and *Q* at the ends. Three saw cuts *R R R* are made in each end of the chuck, and are necessarily staggered as indicated, thus giving the necessary springing feature to the chuck, which is hardened and drawn to the proper degree of temper.

The cup-shaped closer *J* is attached to a sliding-rod *S*, which extends to the rear end of the lathe spindle, where means are provided for sliding it to and fro, and locking it in its working position, which is the one shown in Fig. 22.

The closer *J* has an internally tapered face *T*, and the spring chuck *L* being placed with its tapered face *N* against the face *T* of the closer, and its face *O* against the face *K* of the sleeve, the rod *S* and closer *J* are forced toward the right, thus forcing the spring portions of the chuck inward and clamping the work.

The advantages obtained by this style of chuck are greater gripping capacity with the same exertion of force for operating as required for the older styles of chucks, and greater accuracy, by

having two points of support and thereby decreasing the inclination to "wabble" where the work is long.

MACHINE-STEEL COLLETS

SEVERAL years ago we had charge of the tool room and battery of hand and automatic screw machines in a factory making bicycle cones and nuts, and there was continual trouble caused by the breaking of the spring collets in the screw-machine chucks.

The machines were all first-class, but the collets, which were all made of tool steel, and carefully hardened and drawn by the different makers, seemed to crystallize and break with equal impartiality, and the collets we made ourselves fared no better, so at last, after repeated trials, we determined to try a few made from cold-rolled machine steel and case-hardened. We turned up four exactly the same size in every way as the original ones of tool steel, and case-hardened them with cyanide in an ordinary forge. They were put in the nut machine, where

they would get the hardest usage, and as a result of their staying qualities we replaced every collet in the shop with those made of machine steel, as fast as the tool-steel ones gave out.

Three of the first machine-steel collets we made were in continual use for over two years, when one was broken accidentally, and from the time we began using machine steel we did not average to break more than one collet a year for each machine, while the wearing qualities were far beyond our fondest hope.

BUSHINGS FOR SPRING COLLETS

WHERE spring chucks are used it often happens that a collet is wanted with an odd-size hole for some small lot of special work, and it will be found very handy to have a collet with a straight hole clear through it, as large as the outside diameter will allow, for taking bushings. We make these bushings like Fig. 24; they are of soft steel and case-hardened. A pin in the chuck holds the bushing flush with the outside of the collet, the bushing is pushed in and turned

until the pin slips in the straight part of the slot, and then turned so as to bring the pin to the closed end of the slot. The slot being cut

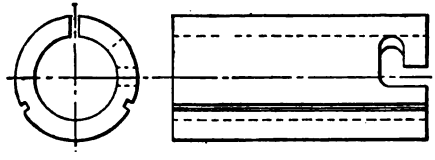


FIG. 24. — Bushing for Spring Collet.

in the direction of the rotation of the work, the bushing is held in while the machine is running and can be easily removed with the fingers when the machine is stopped.

A SPECIAL CHUCK

IN Fig. 25 is shown a special screw-machine fixture (or chuck) made for finishing the piece *A*.

The first operation was to turn one end and cut the piece from the bar of cold rolled stock; the second operation — the turning of the other end — was done in the fixture. A piece of cast-iron *B* was bored and threaded to fit the end of

the spindle, and turned up all over. A hole was then bored and bushed with a steel bushing, hardened, lapped and ground, to give the proper throw. A hardened steel block *C* was sunk into the face of *B* to act as the solid jaw.

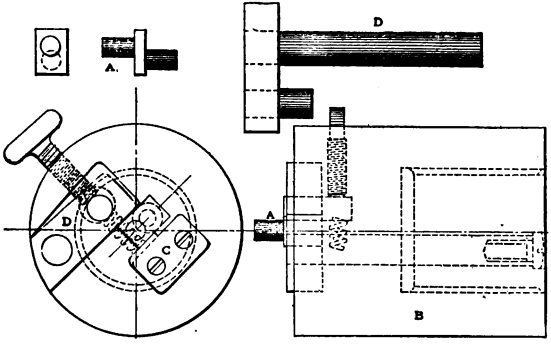


FIG. 25. — A Special Chuck.

D is the clamp, or moving jaw, that is tightened against the work by the thumbscrew; a coil spring, which presses against the short pin on *D*, opening the jaw when the thumbscrew is released.

LUBRICANT FOR SCREW-MACHINE WORK

In mixing soap-water for a lot of automatic screw machines, using soft machine steel for making bicycle cones and nuts, a few years ago, we had trouble with the mixture caking up and clogging the pipes; and where a pipe feeding water on to a tool clogged, it meant a burnt forming tool and a lot of extra grinding. The cutting preparation that was bought was as bad as our own, and we began experimenting. Now it had been the practice in fixing up our soap water to take a bucket of lard oil, add about half a can of potash, boil it and then put it in the tank and add water till it looked right and felt slippery, like wet borax. After considerable trouble we hit upon the right mixture. The formula is as follows: To each barrel of water, add two buckets of lard oil and one can of Babbitt's lye (potash); put it in the tank *cold* and let the pump do the mixing. The result is a creamy colored and feeling mixture that keeps the tools cool and clean and does not cake or clog pipes or pump. When the soap water begins to look thin

and watery or feel gritty, add a bucket of lard oil and half a can of the lye; and if it isn't all right in an hour, add some more. If it gets too thick, add cold water (never hot under any circumstances) and you'll never have trouble with clogged pipes. We ran this mixture for two years in pipes that were really too small, but which the management refused to change, and never had one clog after we began using it.

LUBRICATION IN THE AUTOMATIC

We have been for a considerable time intimately connected with the automatic type of machine, and from careful observation are convinced that a deal of expense both in time and tools can be saved by more attention to the oil feed. As a rule the machine comes into the shop from the makers fitted up with an ordinary spreader, and this has to do duty upon all jobs alike if left to the average operator. Result, when drilling, counterboring, etc., in deep holes, tools get dulled rapidly or burned, and the machine is standing idle for far too great a propor-

tion of its time. As another illustration of how this expense may be avoided with a little ingenuity and forethought, we show a sketch of an arrangement for oil feed rigged up on a screw machine by an operator who had his heart in the work. The spreader was taken off

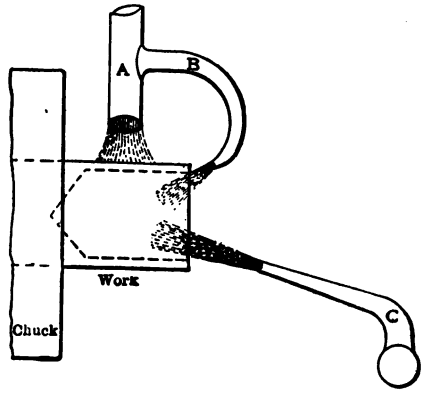


FIG. 26. — Oil Pipe Arrangement.

and a piece of pipe *A*, Fig. 26, put into its place, thereby insuring a good supply of oil to the forming and cut-off tools. Screwed into *A* was a short length *B*, bent to throw the oil right into the drilled hole. Another piece *C* was branched

from the main oil pipe and given an upward bend to throw into the work from the bottom. The job required a $1\frac{3}{8}$-inch hole $1\frac{1}{2}$ inches deep in $1\frac{7}{8}$ inches stock, and, despite a copious flood of lubricant on the outside of the work, the drill, a fluted one, required grinding much too frequently to be either agreeable or economical. So the above arrangement was made at small cost, and we could then run the machine for more than a week on end without grinding. In most cases some little scheming may be found necessary to clear the turret tools, especially when using box tools, but when once this difficulty is overcome the operator has time to loaf where before he was hustled to death to keep things going.

CENTERING DEVICE

THE device in Fig. 27 is used for centering long work, which is afterward ground after being turned but before cutting off.

It consists of a tool- or machine-steel socket bored to accommodate a standard combined drill

and countersink, which is held by means of a set-screw. The hardened steel ring will insure the work running true, and can be replaced by various sizes of rings to accommodate different diameters of work. The other end of the work is centered by reversing and holding in a spring

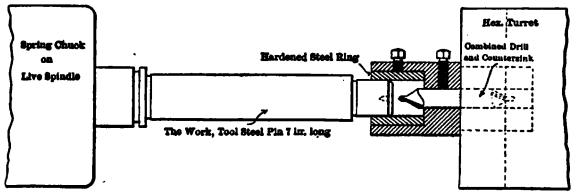

Spring Chuck on Live Spindle
Hardened Steel Ring
The Work, Tool Steel Pin ¼ in. long
Hex. Turret
Combined Drill and Countersink

FIG. 27. — Centering Device.

chuck, and centering with a similar drill and countersink.

An advantage which the device shown gives, is that the work will run perfectly true for threading in the die, which is done after centering.

AN OIL GUARD

A LIBERAL amount of oil was being used on the two-spindle automatic, and the second operation spindle as it ran forward to receive

the work from the other spindle was getting, as indicated in Fig. 28, rather more lubricant than it required. Consequently, a fine spray of oil was thrown over the machine guards, more or less oil was carried back with the spindle into the head, and part of this oil then worked

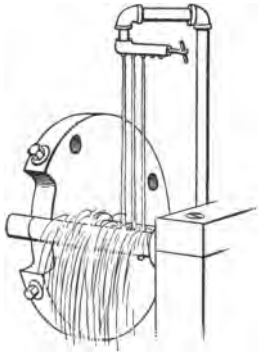


FIG. 28.

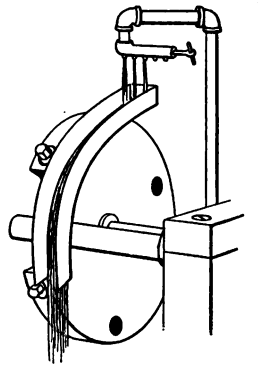


FIG. 29.

An Oil Guard.

out between the pulleys and ran on to the driving belts. To divert the lubricant from its course until the spindle had been drawn back into place in the head and the work was in position to be operated on, one of the operators made and applied a guard as shown in Fig. 29.

This guard was made of tin and curved to suit the turret. It was provided with two ears which were filed out to receive the turret tool binding screws, and was thus easily put on and securely held in position. In operation it proved very satisfactory, for it kept the spindle free from oil and yet in no way interfered with the working of the turret.

A SAMPLE-BOARD FOR SCREW-MACHINE WORK

SOMETIMES you see in a screw-machine department a sample-board with every hook loaded about as shown in Fig. 30. In the case of large shops, especially such as make a great variety of small parts, the rapidity with which samples accumulate is anything but a laughing matter. It may be that a card catalog properly arranged would in some shops be just the thing for the screw-machine department and do away altogether with the necessity for collecting and caring for samples.

In Fig. 31 is shown a sample-board, or set of

boards, rather, that helped us straighten out a lot of samples and get rid of some of the bunches of junk that were suspended on the old board.

FIG. 30. — A Sample Board Corner.

This sample-board requires little description, the sketch showing the general arrangement fairly well. The pieces at top and bottom, be-

tween which the boards swing, may be fastened to the wall or to uprights at the back of a bench. The number of boards may be varied, of course, to suit different requirements. With the four swinging boards arranged as shown eight sep-

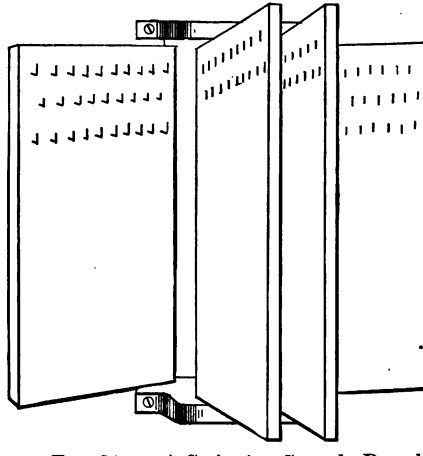


FIG. 31. — A Swinging Sample Board.

arate surfaces were obtained, thus making it possible to place the samples for several different departments by themselves. Where preferred, however, screws may be grouped in one section, nuts in another, and so on.

Now a word about tagging samples: Some simply tie on the tag, and, after writing on the name or number of the piece, throw the string

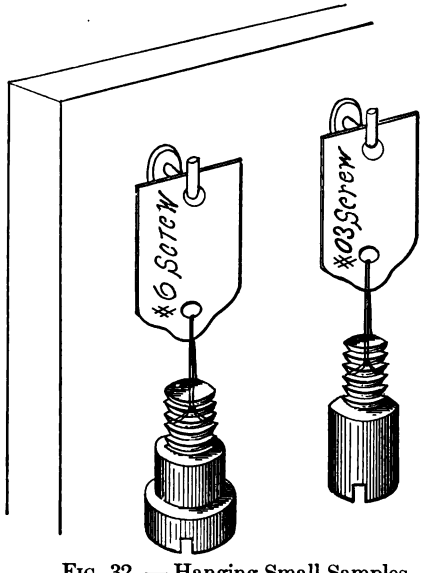


FIG. 32. — Hanging Small Samples.

over a hook where the tag hangs in any old way — usually bottom end up and wrong side out. A good way to hang small samples is indicated in Fig. 32. Punch each tag so that it may be hung

on the hook, and, after putting on the name and number of the piece, shellac the tag on both sides. This will prevent oil from soaking in from either side, and, as the tag will always be clean, there will never be any difficulty in identifying the sample.

SETTING AUTOMATICS

We give below our practice in connection with the setting up of Brown & Sharpe automatics. The system we follow has proved very satisfactory. When we get a piece to make and are sure that we will have it again we lay out a set of three cams. When figuring out the cams we write up the order of operations, speed, gears, order of belts on countershaft, and list of tools to use, giving them a "set-up" number and a box number with the time for each piece, number of pieces in 10 hours (less 10 per cent.), material and drawing number as in Fig. 33. The number 2 after "chuck" on the setting-up print is the size of the machine. The sketch of the piece is also put on this sheet, but tool setters are not

ORDER OF OPERATIONS	
Rev.	
21	Feed to Stop
28	Revolve Turret
91	Drill — Large hole
28	Revolve Turret
140	Drill — Small hole
28	Revolve Turret
63	Counterbore
28	Revolve Turret
21	Tap — Large hole
28	Revolve Turret
14	Tap — Small hole
70	Form. Back Tool
140	Cut off, Front Tool
700	Total Revolutions to make one piece

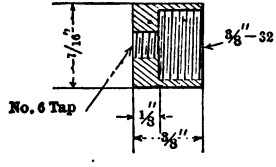
SET UP No. 60	
7/16"	Square Chuck No. 2
7/16"	Square Feed Chuck No. 2
1	Stop
2	Drills and Holders
1	Spec. Counterbore and Holder
2	Taps and Holders
2	Forming Tools
3	Cams
Kept in Box No. 61 in Tool Supply	

TIME
35 Seconds each or 925 Net in 10 hours

Dwg. No. 7445 Mat'l 7/16" Sq. Brass Pce. No. 1461

SPEED	
1200	Revolutions — Forward
1200	Revolutions — Backward

GEARS	
Teeth	
60	Driving Shaft
60	First on Stud
72	Second on Stud
84	Worm Shaft



COUNTERSHAFT	
Fastest from Line Shaft	
Fastest on Cone	
Large Pulley to Spindle	

FIG. 33. — A Setting-up Print for Brown & Sharpe Automatic Screw Machine.

allowed to go by it as the drawing may have been changed since last used. We send this to the draftsman and he has a tracing made and furnishes three blue-prints. One is pasted on a folder and put with the tools in a box for the tool setter's use; one is put in the foreman's book and kept for reference, so that when a piece has to be made and no set-up sheet is made for it he can look up the sketches on these prints and find one that will do. The third copy is kept in the tool department. Our practice is to give the tool setter a tag that reads, say, "10,000 $\frac{7}{16}$ square-brass nuts, Drawing No. 7445; Piece No. 1461." He gets the drawing and on it appears "B. & S. Set-up No. 60." He goes to the tool room and calls for the "set-up." The record shows this to be box 61. The box is handed to him with the folder and he sees what tools he has to get and proceeds to put the tools in the machine in order. By following the print he can set up the work on any No. 2 B. & S. screw machine, and know that it will be all right. We have never had but one man that had trouble. He could set up the job without the print. One

piece he had was to be threaded and nurled. He worked five hours, tried all the dies he could lay hold of, and finally concluded the cams were not figured out right. When asked if he followed the order of operations he admitted he had not, but that he knew the cam lobes for each tool. His trouble was caused by running the die on with the nurl lobe and nurling with the one for the die; they did look very much alike.

In giving the order of operations the revolutions of the spindle are noted for each, and the total for each piece. We generally make the necessary special tools such as forming tools and special cut-offs, and put them in the box with the cams. If the piece to be made has to be turned and has more than two diameters, it pays to keep a turning or box tool set up. If of only two diameters, we use the regular turners. Other tools such as drills, reamers, tap and die holders are kept on hand in sufficient numbers to supply the demand.

LINING UP A SCREW MACHINE

We have in our shop a workman who recently came to this country. The men, knowing that he had not been in America long, naturally kept an eye on him when he started in, to see how his ways of doing work compared with our methods. The first morning he came in he got the job of lining up the old screw machine, and the men thought he had struck a tough proposition, for they knew the machine was in bad shape. But from the way he went at it, we think the job was a very easy one for him.

He first took a piece of flat steel, $\frac{1}{4}$ x $\frac{3}{4}$ inch by 5 inches long, and cut a slot in it to within $\frac{1}{2}$ inch of each end, the slot being wide enough to admit easily a $\frac{5}{16}$-inch screw. He then took a piece of $\frac{3}{8}$-inch stock, about 4 inches long, turned it down at the end to $\frac{5}{16}$ inch and cut an 18-per-inch thread on the reduced portion. He did the same to another piece, about 7 inches long, and drilled and tapped in it two $\frac{1}{4}$-inch holes about 4 inches apart. He then clamped the three pieces together as shown in the sketch Fig. 34, the shorter

$\frac{5}{8}$-inch piece *A* going in the chuck. The piece *B* for the turret was turned true for a test bar. The piece *C* extending out over it was provided with two screws, which were adjusted until they very nearly touched *B*, a piece of tissue paper being used in the testing. Then, by slowly rotating the spindle, *C* was swung around plug *B*, and it

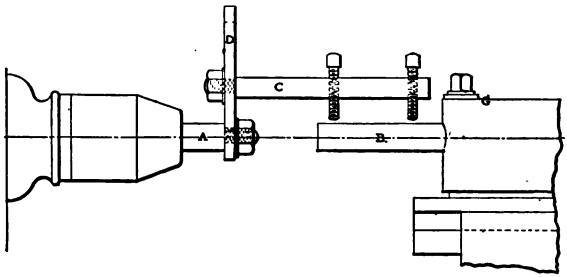


FIG. 34. — Lining up a Screw Machine.

was found that it was out over $\frac{1}{32}$ inch to one side. By taking the head off and filing one of the dovetailed sides and drawing in on the other, our friend soon had the head lined up to perfection. He did a very neat job in filing. When he placed the head on to see how near he was, he would feel with a strip of brass about 0.005 inch

thick to see if he was filing the dovetail straight; in this manner he kept it pretty square. The idea of slotting the arm *D* was to permit of this piece (and also *C*) being adjusted as required.

DRILLING CAM DRUMS ON THE AUTOMATIC

FIG. 35 shows the way we have generally drilled cam drums on automatics — a job which in common with other screw-machine men we have had to tackle occasionally: Instead of backing up the ratchet by a block to another machine or convenient post, or clamping a drilling post or "old man" to the drum, a belt shipper dog from the machine is used, this having a good deep center drilled in it and the slot being filed out to fit readily over the edge of the pan, as indicated in the sketch. The dog may be quickly adjusted to bring the drill square, sidewise, with the drum, it then being clamped fast by its screw. The drum is next rotated slightly in the required direction to point the drill toward the center of the shaft, and the hole is then easily drilled.

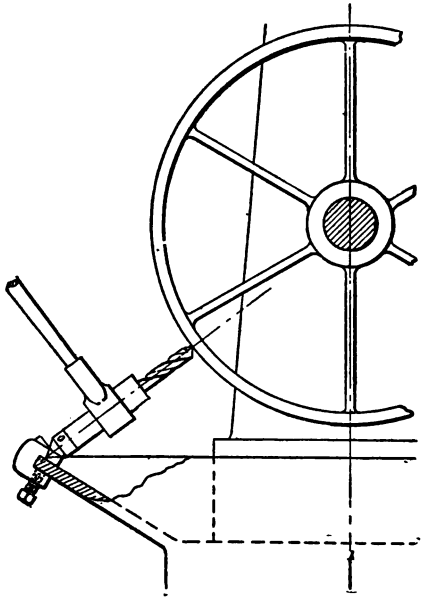


FIG. 35. — Ratching a Hole in a Cam Drum.

A TIME-SAVING KINK

A FEW seconds gained on each piece cut off by an automatic screw machine is worth a little scheming. We noticed that in some operations on our automatics, especially threading, the

work was finished some seconds before the dog moved the pin connected with the differential gear. The dogs were already close up. This can be altered to some degree by making the triangular tops overhang more than is shown in Fig. 36, thus shortening the distance *A B*. This

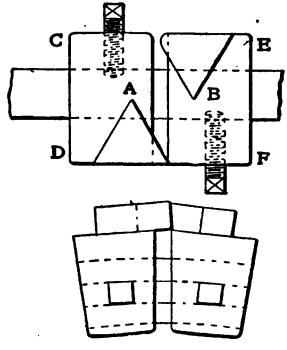


FIG. 36.

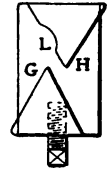


FIG. 37.

Feed Motion Controlling Dogs.

meets one difficulty, but it often happens that the sides *C D*, *E F*, prevent other dogs from being brought up as near to *A B* as is desirable, especially when a machine is making two articles per revolution of the cam disk, and the dogs have to be crowded up close. To meet both

these objections we made one dog to carry both triangular pieces as in Fig. 37, leaving space *G H* just wide enough for the pin to pass through and making a hollow at *L* for it to drop in as it swung over. The time of threading in one case dropped from 14 to 8 seconds. In cutting off pieces of small diameter a saving was also effected. Of course the space *G H* can be widened a little for other short operations.

MAKING SPRING CHUCKS

In this book on Screw-Machine Kinks some particulars regarding the making of certain classes of tools for these machines should be of interest and value to the reader.

The description here given of how our spring chucks are made is not presented as showing the best method necessarily, but the method does give satisfactory results.

From a lathe where two chucks were made in a piece, as shown in Fig. 38, and in quantities of from two to a dozen, the job was transferred to a turret lathe when the manufacture of bicycle

parts taught us what could be done in that machine with a forming tool, and Fig. 39 shows a collet or chuck formed sufficiently accurate with the back end faced and the clearance hole drilled

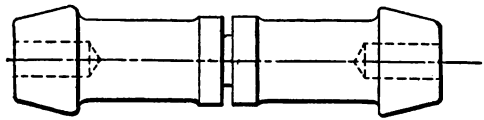


FIG. 38

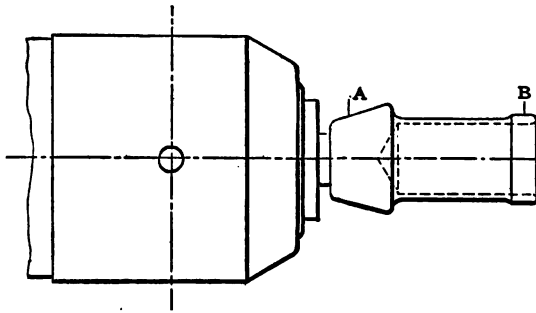


FIG. 39. — Making Spring Chucks.

and reamed, ready to be severed from the bar by a cutting-off tool in the cross-slide. The tools for this operation are not shown, but will be readily imagined by anyone familiar with turret-lathe work. The next operation was to remove

the tool marks at *A* and *B* with a file. The chucks were then put into a machine of the right size and there held in the same manner as when being used while the hole at the front was drilled, bored and reamed and the front end faced. When a screw machine was not available the chucks were bored in the lathe fixture shown in Fig. 40. This was held on the live center at *C* and in a steady-rest at *D*. *E* acted as a hold-back and driver, and did away with bolts, etc. It will be noticed that the work is held by the same surfaces as when in the turret lathe. In operation the blank chuck was first put into the recess in piece *F* and then placed in the fixture. Tightening nut *G* forced the work into the taper hole at *H*, while the back end was centered by piece *F*. For some time after making these chucks in lots of one hundred or more, they were all split while held on an arbor or plug driven into the large hole in the back end, and as this hole varied in size the plug would not fit properly, and often enlarged the back end and caused annoyance while being inserted and removed. In addition to this the hole was not always exactly

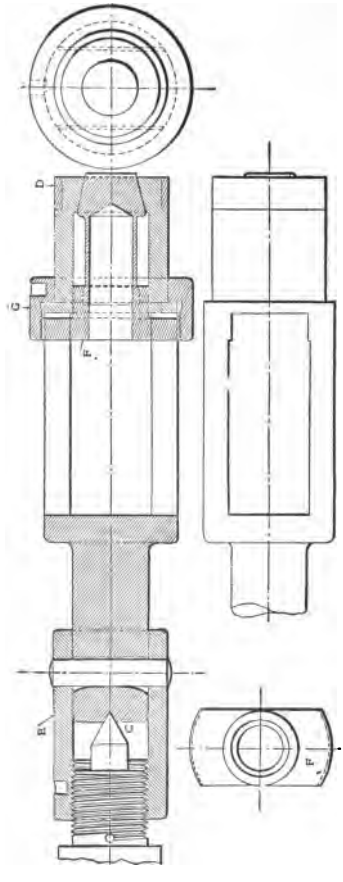


FIG. 40. — Making Spring Chucks.

true, and this increased the liability of the saw slots not being central. To support the chuck at the front and prevent the work from coming off of the arbor, a block was placed against the front end and the foot center was forced up against it but did not hold it central. These difficulties were finally overcome by the tools shown in Fig. 41, which were designed to be used in a universal milling machine.

The steel adapter *I* was bored to fit the chuck, formed with taper shank to fit the hole in the spindle of the dividing head and provided with a screw to clamp the work and cause it to rotate with the head spindle. The special foot stock *J* was made to use in place of the regular one, and was provided with spindles like *K* to fit different chucks. With these fixtures the work was not bruised, the slots were central and the time required to split the chuck was greatly reduced from former practice. For very small and odd-sized chucks a spindle with a 60-degree end was used. After removing the burrs and hardened, the chucks were polished and the back end drawn to a spring temper. To hold

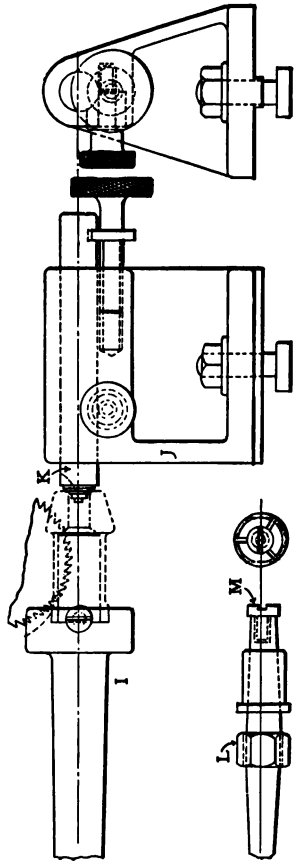


FIG. 41

FIG. 42

Making Spring Chucks.

them while polishing, the arbor and bushing shown in Fig. 42 were used, the arbor fitting the spindle of a speed lathe and split bushings being made to fit various sizes of chucks. In use the chuck is pressed against the shoulder on the bushing, which expands the latter sufficiently to hold the chuck. Nut *L* is used to loosen the bushing on the arbor and release the chuck. Screw *M* prevents the bushing from dropping off.

FIXTURE FOR OPENING SPRING CHUCKS WHEN HARDENING

SPRING chucks in some shops are always opened when hardening, by putting a taper arbor by hand into the red-hot chuck, which is then dipped in the water tank. This results often in bad work, one of the three jaws bending too much, or the opening being too large. Since using the small fixture shown in Fig. 43 we have had no difficulty of this kind. The evenly heated chuck is put on center *a*, and the pointed arbor *b* pushed into the end, the previously adjusted stop-ring *c* preventing the jaws being

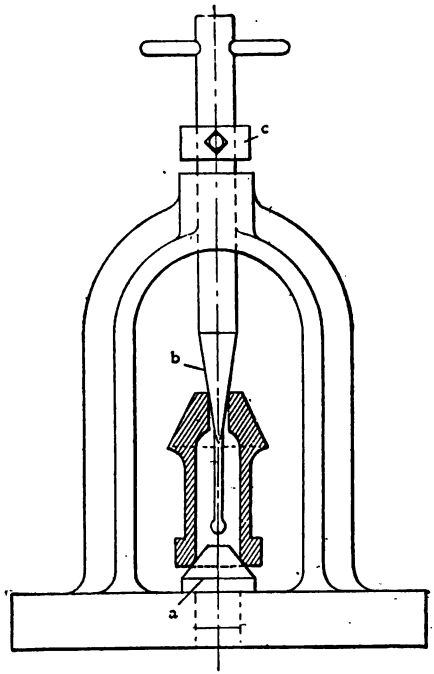


FIG. 43. — Fixture for Opening Spring Chucks.

spread too far apart. The chuck is handled with common tongs when put in the apparatus and when dipped into water. For heating we use molten lead.

HARDENING SPRING CHUCKS

A GOOD way to hold spring chucks from opening while being tempered is to not saw the slots clear to the end, but leave a little bridge of metal from one jaw to the next one. After the chuck is hardened and drawn, the little bridge can be broken by inserting a wedge or chisel, or, better still, it can be sawn away with a thin copper disk charged with emery. On small chucks the amount of metal to be left need not be more than $\frac{1}{32}$ inch, while on large ones the amount can be increased to $\frac{1}{16}$ inch or a little more. Chucks held in this way usually remain as made. The sketches, Figs. 44 and 45, show clearly the point to be left.

Most, if not all, chucks fail by breaking either at *A* or *B*, Fig. 44, and, so far as we have been able to observe, the common practice is to make them like Fig. 44, in which the inside corner at *C* has only a small round left by the boring tool or drill, and is almost invariably under the outside corner at *D*, which in many cases is also quite small and abrupt, while the spring part is

quite thin. In the majority of chucks the corners at *B* also are left nearly square. This construction leaves a thick body of metal at *F*, as compared with *E* and the unequal rate of heating

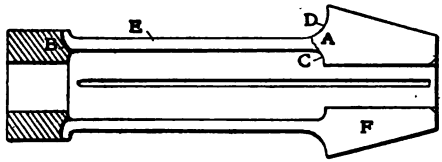


FIG. 44.

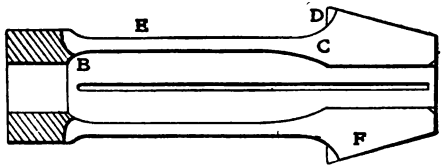


FIG. 45.
Spring Chucks.

and subsequent cooling sets up severe strains in the corners.

For several years we have made chucks like Fig. 45 instead of Fig. 44, cutting away the outside as shown by the dotted line, thus leaving a

good full curve at *D*, while on the inside the spring *E* is made to a long curve, thus avoiding a sharp corner at *C*. The corners at *B* are also made very full.

LAYING OUT FORM CUTTERS

As most readers probably know, a circular tool is usually (and should always be) ground below the center, and nearly all screw-machine men will grind them that way whether they were intended to be so used or not; for it makes a much freer cutting tool and the edge will hold much longer.

On a smooth, coppered surface draw two parallel lines, the distance apart that the center of the cutting tool stands above the spindle center, or that the line of the cutting edge is below the cutter center, and they should be the same. Taking a point on the lower line as a center, with a pair of dividers accurately lay out the piece to be made; that is, with the dividers draw circles of diameters equal to the diameter of each different diameter of the finished part.

This should be done very accurately. Now with dividers set to the radius of the greatest diameter of the cutter, set one leg of the dividers on the point where the smallest diameter of the finished piece crosses the lower line, as shown in the sketch, Fig. 46, and describe an arc crossing the

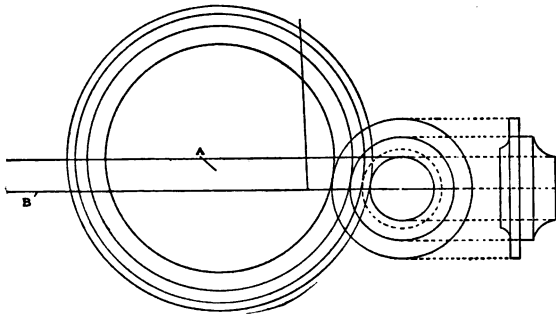


FIG. 46. — Laying out Forming Tools.

upper line at *a*. Now carefully preserve this dimension, and with *a* as a center describe a circle which will be the outside or greatest diameter of the cutter. Then, with *a* still as a center, take the next largest diameter of the finished piece at intersection of lower line as a radius and inscribe another circle, and so on with each

separate diameter until a circle and a size for each have been taken. Now double each dimension taken with *a* as a center, and you have the exact diameter of each part of your cutter. Don't be scared when you place your finished part against your cutter, for it won't fit a little. Wait till you have milled it to your cutting line *B* and then try it, and if you have been careful to get accurate measurements, it will be a perfect fit.

It is advisable to make a grinding gage, one end fitting in the screw hole in the center of the cutter, and the other coming out to agree perfectly with cutting edge. If the cutters are all the same distance above the spindle centers, one grinding gage will answer for all cutters.

DIAMETERS OF CIRCULAR CUTTERS FOR FORMING TOOLS

THE preceding method of laying out circular cutters, while correct, in so far as graphic methods can be, is not accurate enough for the requirements of shops where the limits for error in work

are very small. When a tool of this character is to be made in such shops, a rule may be used as follows:

A cutter is to be made, for example, to turn or form a piece, Fig. 47, which has two diameters, 1 and $1\frac{1}{2}$ inches; the cutter center is to be $\frac{1}{4}$ inch above the center of the work, and the ground

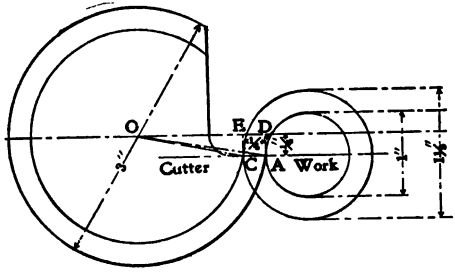


FIG. 47. — Diameters of Circular Cutters.

face of the cutter is to be in the horizontal plane of the center of the work, as shown in the sketch. We start by assuming the large diameter of the cutter, which in this case will be 3 inches. The cutting edge *A*, which is on the circumference of the large circle, reduces the work to the small diameter, or 1 inch. The larger diameter of the work must be cut to size by cutting edge *C*,

which is on the smaller step of the cutter. The diameter of this circle is unknown, and to find $O\,C$, the radius, is the problem.

A little study of the sketch will make it plain that

$$O\,D = \sqrt{(O\,A)^2 - (D\,A)^2},$$
$$O\,E = O\,D - E\,D,$$
$$O\,C = \sqrt{(O\,E)^2 + (E\,C)^2}.$$

This gives the radius of the circle which determines the cutting edge C. The operation is repeated for every diameter required.

The results of this method are as accurate as figures can make them, the accuracy being limited only by the number of decimal places to which the results are extended.

MAKING A CORRECT FORMING TOOL

Some time ago we got an order for a forming tool for a turned piece, shaped as shown in Fig. 48 at B. The customer wished to have the angle of rake 8 degrees and the angle of clearance 7 degrees. It is obvious that the shape of section

of piece B, on line $a\,b$, differs from that on the diameter of the same body. The arcs become elliptic, the straight lines joining them become

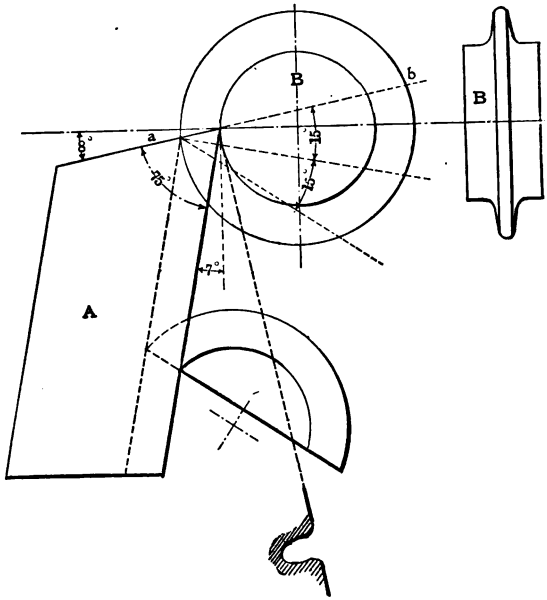


FIG. 48. — Forming Tool and Tool used in Finishing It.

curved, and the whole length is shorter. We solved the question perfectly and yet in a very simple manner. We turned the body B out of

tool steel to the exact size. We divided this into two parts by a cut along the line *a b*, hardened the smaller part and used it as a scraping tool for making the finished cut on the derived forming tool, using a shaper. Of course this scraping tool was fixed, as shown in the sketch, within an angle of 75 degrees to the horizontal line of stroke of machine. The result was a very satisfactory one.

MAKING FORMING TOOLS — SOLDERING TOOLS TO HOLDERS

In shops where they do duplicate work in large quantities, it is necessary to have some way of duplicating the forming tools and cutters. The following method has been developed at the United States Armory, Springfield, Mass. The key of this method is the soldering iron, and few people have any idea of the possibilities of that ancient tool.

We use both straight and wheel tools. The straight tools are made with a clearance of 5 degrees and are ground flat on top. We first

turn up a model piece *A* the shape that we want to make. We flat one side *h* and cut the notch *g* to the center. This gives us a cutting face at *i* and makes a wheel tool of the model piece. We solder this wheel tool to a spring tool, the flat part *h* resting upon the tool. Next place a piece

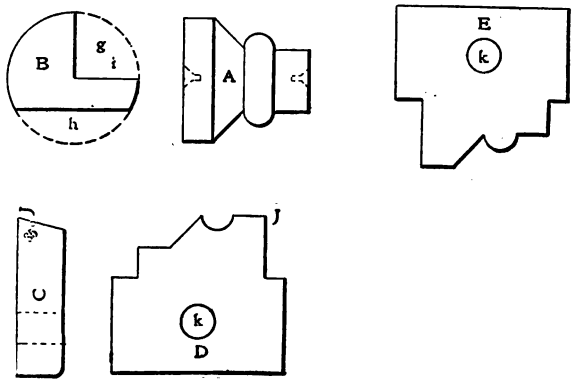


FIG. 49. — Making Forming Tools.

of steel shaped like *C* in the shaper between two 5-degree parallels and plane the edge *J* with the tool *B*. This produces a tool *D* of the required shape to make the piece *A*. As these tools wear out and have to be renewed, it is necessary to make a master tool *E* for making the tools *D*.

The cutters *D* and *E* are fastened to the holder by the screw hole *k*.

TWO CUTTER HARDENING KINKS

FIG. 50 is a sketch showing two styles of circular cutters which, owing to their shape, gave much trouble in hardening. We are aware that

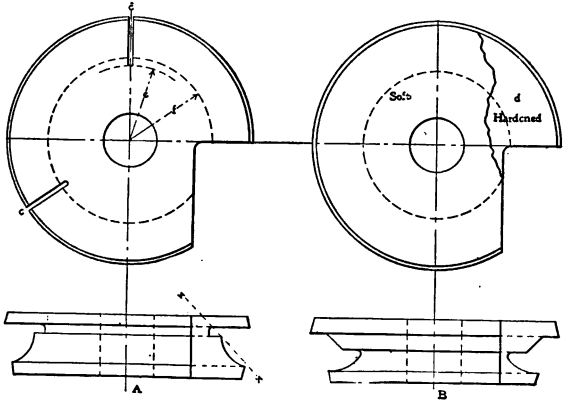


FIG. 50. — The Tools to be Hardened.

cutters could be designed to lessen such trouble and insure hardening without cracking, but in this case we were held to certain sizes given in a sketch.

Cutter *A*, owing to its form, gives more trouble than *B*, and will crack through *X X* almost every time. The cracking is caused by uneven contraction in the metal, the thin flange cooling very quickly and the heavy body slowly. We experimented with different methods of hardening, but without good results, until we hit upon the two schemes indicated at *c* and *d*, both being so successful that the hardening gave me no further trouble.

With a hack-saw or milling cutter about $\frac{1}{16}$ inch thick we cut into cutter *A* in two places, making the divisions about as shown in the sketch. It is very important in making the saw cut that the bottom of the cut be about $\frac{1}{8}$ inch deeper than the smallest diameter of the cutter; or, in other words, radius *e* must be $\frac{1}{8}$ inch less than radius *f*. In the case of cutter *B* we did not make the saw cuts, but simply cut away enough stock to secure a cutting face in the regular way, then hardened a part of the cutter about as shown by the broken line, leaving the rest of the cutter soft.

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